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I, KIM MARSHALL, MANAGER EXAMINATION SUPPORT AND SALES, hereby certify that the annexed is a true copy of the Provisional specification in connection with Application No. PP 2677 for a patent by LYNX ENGINEERING CONSULTANTS PTY LTD filed on 30 March 1998.

WITNESS my hand this Twenty-sixth
day of April 1999

KIM MARSHALL
MANAGER EXAMINATION SUPPORT AND
SALES



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AUSTRALIA

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ORIGINAL

PROVISIONAL SPECIFICATION

BULK MATERIAL TRANSPORT CONTAINERS

The invention is described in the following statement:

BULK MATERIAL TRANSPORT CONTAINERS

The present invention is related to bulk transport containers, and in particular to containers used in road and rail transportation.

Bulk transport fleet operators presently use containers that are designed 5 inefficiently and are unable to carry more payload than they are designed for without damaging the container, or without significantly affecting the containers safety and fatigue life. If such containers consistently carry more load than they are designed for, then unexpected structural failures are likely, along with a higher risk of derailment in the case of rail transportation.

10 The containers presently used by both Australian and international transportation companies to carry bulk product are based on designs that are at least 20 years old. Each new container that is produced is still based on these old concepts, such that the problems inherent in ageing containers will be duplicated in the new containers. Thus, if operators look to maximise the 15 carrying capacity of their containers by increasing payloads the inherent design problems will be exacerbated.

It is an object of the present invention to provide a container for bulk product transportation that is more efficient and cost effective than existing containers.

20 With the above object in mind the present invention provides a container for transporting bulk material having two side walls, two end walls, and a base; the side walls having a plurality of vertical reinforcing members spaced along the length of the side wall, wherein the wide wall between at least one adjacent pair of reinforcing members includes at least one internal ridge running 25 therebetween.

Preferably, there will be at least one internal ridge between each of the reinforcing members.

Preferably, there will be at least one internal ridge between an end wall and a first reinforcing means.

30 Ideally, the internal ridge includes a first wall portion angled from the wall towards the interior of the container, and a second wall portion rejoining the first wall portion to the wall. The angle of the first wall portion is in the direction of

flow during unloading of the material to be transported.

Alternatively, the internal ridge includes a first wall portion deflected inwardly a progressively increased degree relative to the intersection of the side wall and the base, and a second wall portion extending from the first wall portion 5 and being deflected outwardly a progressively decreased degree relative to the intersection of the side wall and the base.

The angle of the first wall portion may be determined by subtracting the natural angle of repose of the transported product, from the angle the container is rotated during unloading. Whilst the first and second wall portions may be 10 symmetrical, they may also be of uneven length.

In further embodiments, the internal ridge may also include a third wall portion between the first wall portion and the second wall portion. This third wall portion may be flat or concave. Any such flat third wall portion may additionally be parallel to the side wall.

15 In some applications, a partial internal ridge may extend along the top edge or rim of the side walls. Such a partial internal ridge may consist of the first wall portion of the internal ridge. In this case an additional strengthening member along the edge or rim of the side wall would be included.

In a preferred embodiment, the base of the container also includes at 20 least one internal ridge extending substantially along the length of the base.

It will be convenient to further describe the invention by reference to the accompanying drawings which illustrate possible embodiments of the invention and improvements over the prior art. Other embodiments of the invention are possible and consequently the particularity of the accompanying drawings is not 25 to be understood as superseding the generality of the preceding description of the present invention.

Figure 1 shows an isometric view of a conventional container.

Figure 2a shows an isometric view of one container of the present invention.

30 Figure 2b shows the container of Figure 2a with a cutaway portion to better show the internal ridge.

Figure 3a shows an isometric view of a further container of the present

invention.

Figure 3b shows the container of Figure 3a with a cutaway portion to better show the internal ridge.

Figure 4a shows a simple cross-sectional view of a conventional 5 container.

Figure 4b shows a simple cross-sectional view of a container of the preferred embodiment of the present invention.

Figure 5 shows a cross-sectional view of a container of the present invention superimposed over a conventional container.

10 Figure 6 shows the arrangement of the internal ridge for a container with a bottom dumping mechanism.

Figure 7 shows the angle of repose diagrammatically.

Figure 8 shows an expanded view of an internal ridge of the present invention.

15 Referring now to Figures 1 and 4a, the shape of a conventional container as presently used can be seen. The basic container includes two side walls 1, a base 2, and two end walls 3. The size of any such container, whether it be for transportation by road or by rail, has certain dimensional limitations. That is, neither the height, nor width, of the container can exceed pre-defined 20 dimensions. These pre-defined dimensions are determined by both rail or road standards, and also, the practical limitations of by loading and unloading facilities.

Accordingly, whilst it is presently desirable in the industry to increase payloads, the size of the actual containers cannot be increased without 25 decreasing the strength of the containers. In this regard, it is noted that the walls of the containers do not extend to the maximum possible dimensions due to the structural requirements of the container. That is, the bulk product transported via these containers places extreme stresses on the walls of the containers, requiring a number of support or reinforcing members to strengthen the walls. 30 This can conveniently take the form of a number of ribs 4, extending around the body of the container. The addition of the necessary number of ribs 4 to strengthen the walls 1, result in a much heavier container and in a resultant

decrease in the aerodynamics of the container, both having fuel cost implications on the profitability of the container. It is also noted that structural maintenance and repairs to such containers are both frequent and expensive and do not guarantee that the operational life of the container will be 5 significantly increased.

It will be appreciated that larger containers will require more ribs or reinforcing members. The present invention reduces the number of ribs that is required when compared to a conventional container of equal size.

Referring now to Figures 2, 3 and 4b, the preferred embodiment of the 10 present invention can be seen. The container of the preferred embodiment also includes two side walls 5, two end walls 7, and a base 6. However, the present invention also includes at least one internal ridge 8. The main element of this internal ridge 8, is a first portion 8a, which extends from the wall at an angle towards the interior of the container. A second portion 8b, can be adapted to 15 complete the internal ridge 8, by rejoining the wall 5, to the end of the first portion 8a.

It is noted that as we move along the first portion 8a from the side wall 5, the angle between the side wall 5 and the position on the first portion 8a relative to the intersection of the side wall 5 and base 6 progressively increases. 20 Similarly, as we return along the second portion 8b, the angle relative to the intersection between the side wall 5 and base 6 progressively decreases.

The angle 11 at which the portion 8a, extends from the wall 5 towards the interior of the container is chosen to ensure that the product to be carried by the container is unloaded completely. That is, the angle is preferably dependent on 25 the type of product carried and on the method the operator uses to unload the product. The dimensions of the internal ridge 8, are further determined as a function of the structural strength required and of the natural angle of repose of the material that is to be transported.

The angle at which the first portion 8a extends towards the interior of the 30 container may be determined by the following mathematical formula:

$$\theta_1 \geq \theta_2 - \theta_3 - 90$$

where

$\varnothing 1$ —is the angle between the vertical wall 5, and the first portion 8a.

$\varnothing 2$ —is the angle the container is rotated in the unloading facility.

$\varnothing 3$ — is the natural angle of repose for the product to be transported.

As seen in Figure 7, the natural angle of repose 13 is dependent on the
5 product 12 desired to be carried, and can be determined by pouring or dropping
the material 12 on to a level plain so as to form a substantially conical hill. The
angle of repose 13 is then determined as the angle between the horizontal plain
15, and a line extending from the base of the cone to the top of the hill.

In some circumstances, it may be more appropriate to use the following
10 formula:

$$\varnothing 1 \geq \varnothing 2 - \varnothing 3 - \varnothing 4 - 90$$

where

$\varnothing 4$ —is the cohesion of the material to be transported when wet.

Essentially, the shape of the first portion 8a of the internal ridge 8 can be
15 determined on the basis of the natural angle of repose 13 of the material which
is to be carried. The second portion 8b will depend on the structural and
manufacturing requirements of the container and may be derived from detailed
structural analysis of the structural strength and stiffness requirements of the
container. Whilst the second portion 8b may have a similar angle and length to
20 the first portion 8a, this is not a requirement of the internal ridge. That is, the
second portion 8b may be shaped differently to the first portion 8a, in that it may
be curved, or flat. Alternatively, the length of the second portion 8b may be
different to that of the first portion 8a, and accordingly the angle of the second
portion 8b between the wall 5 and the second portion 8b will be different. The
25 shape of the second portion 8b of the internal ridge 8 will depend on the
limitations, such as space constraints, of the container, and on the number of
internal ridges 8 in the wall 5, and to some degree on manufacturing facilities.
Whereas the first portion 8a is based on the angle of repose 13 as discussed
above, the second and third portions 8b, 8c are chosen to complete the internal
30 ridge 8, and fulfil the structural requirements of the container.

The length and shape of the internal ridge 8, will depend on the structural
requirements of the side walls 5 and the base 6. It will also depend on the

spacing between supporting frame members 9, and the natural angle of repose of the material. As the distance or spacing between the supporting frame members 9 increases, it will be necessary to increase the depth 16 of the internal ridge 8, to ensure the necessary structural strength. Accordingly, it is 5 possible to design a container specifically for a certain type of material to be transported, by considering the mass of the material and the pressure the material will place on the walls of the container.

A container constructed with a internal ridge of the present invention provides a container that is able to transport bulk product. Furthermore, the 10 internal ridge acts as an in-built longitudinal structural stiffener. This internal ridge, then ensures that the structural requirements, such as strength, fatigue resistance, and buckling capacity, are met, while ensuring that more product can be loaded into a container that has the same exterior dimensions as a conventionally designed container. This difference in carrying capacity can be 15 seen in Figure 5, where the shape of a new container of the present invention is superimposed over a conventional container. The shaded area of Figure 5 shows the extra volume that may be loaded into the new container of the present invention.

The internal ridge 8 is designed to run along the length of the side wall 5 20 between the supporting frame members 9. Depending on the requirements of the container, for example the placement of locking members 16, the shape and design of the internal ridges 8 may vary between the supporting frame members 9, as seen in Figure 2a. Alternatively, as shown in Figure 3a the internal ridge 8 may be consistent in each panel of the side wall 5.

25 As can be seen from the figures, it is also preferable to include a partial internal ridge 10 at the top of the container. This partial internal ridge 10 may be formed by a first portion which extends at an angle towards the interior of the container. That is, the partial internal ridge 10 does not include the second portion of the internal ridge 8. Ideally, such a partial internal ridge 10 would also 30 include an additional strengthening member 11 which forms the rim of the container. This rim 11 effectively compensates for the omission of the second portion of the internal ridge, thereby ensuring that the structural strength is

sufficient. It will be understood that finite element analysis or other structural analysis can be used to determine the depth of the internal ridge and the thickness of the material to be used for the side wall of the container. Again the depth may be calculated depending on the spacing of the supporting frame 5 members 9, and on the pressure exerted by the material to be carried. The exact figure is derived by applying strength of material theory as well as theories of structural mechanics.

The number and the placement of the internal ridges may be dependent upon the size of the container. As can be seen by a comparison of Figures 1 10 and 2, the addition of the internal ridge 8 reduces the number of strengthening ribs 4 required on a conventional container. This reduction in the number of ribs decreases the weight of the container, and also improves the aerodynamics of the container. Both these features result in a more cost effective container.

The internal ridge 8 may also include a third portion 8c which joins the 15 first portion 8a to the second portion 8b. This third portion 8c may be used to further improve the structural requirements of the internal ridge 8. Accordingly, depending upon the application, this third portion 8c may be flat or concave. Further, it may run parallel to the wall 5, or extend at some angle relative to the wall 5. Generally, the longer the third portion 8c is, the stronger the internal 20 ridge 8 is. However, if the third portion 8c is longer than the first portion 8a then some structural strength is lost, and accordingly it is desirable that the third portion 8c not exceed the length of the first portion 8a. Whether a third portion 8c is adopted will again depend on the required strength of the structure as well as any space constraints on the container.

25 The container of the present invention may be used for bulk transportation by either road or rail. It may also be adapted to be used on containers designed for rotary dumping or tipping, or for bottom dumping. The orientation of the internal ridge will depend upon this unloading method. That is, the first portion 8a is always aligned with the flow of the product being 30 unloaded so as to ensure that no product gets caught up inside the container. If the angle of the internal ridge is not designed so as to ensure that all the product was unloaded, it would be possible for trapped product to unbalance a

container thought to be unloaded, thereby possibly causing derailment or collapsing of the container. It will also be understood that the base 6 of the container may also include at least one internal ridge, thereby strengthening the base of the container. The internal ridges running along the base of the 5 container, may go over the wheels and extend through substantially the entire length of the container. Such floor ridges can be constructed having two main functions. One being operational, to bridge over the wheel thereby adding greater interior volume, and secondly structural as the ridge is again designed to provide structural strength. The parameters of the floor ridge are established 10 using structural analysis. The height of the floor ridge is a function of the depth of the container, of the material properties of the product carried, and of the size of the wheels. The dimensions of the floor ridge will also depend on the spacing of the supporting members.

By the addition of at least one internal ridge in the wall of the container, 15 the present invention results in a container that is lighter than conventional containers as the side wall containing the internal ridge does not require as many structural reinforcements as conventional containers, since the internal ridge itself adds to the structural strength of the wall. Again this can be seen by comparison of Figures 1 and 2, whereby the number of ribs or strengthening 20 elements is less than in the original design. The decrease in the number of ribs 9 also leads to a cheaper container. The decrease in the number of vertical elements, and protruding parts generally improves the aerodynamic shape of the container, thereby making a more efficient and economical container. Further, because fewer welds are required the design ensures that there are 25 fewer areas of stress concentration, thereby making the improved container more fatigue resistant.

In summary, the present invention provides a container that fits into the prescribed parameters, such as the maximum dimensional requirements, but still allows for an increased payload capacity without sacrificing structural 30 strength. The more efficient structural design means that the container is lighter and more aerodynamic. Furthermore, the shape of the container is such that the product unloads easily and no product is left in the container after unloading

operations. The angle and shape of the side walls and internal ridge are designed to take into consideration the products natural repose angle as well as the operators loading methodology, thereby ensuring that efficient unloading is achieved.

DATED this 30th day of March, 1998

LYNX ENGINEERING CONSULTANTS PTY LTD

WATERMARK PATENT & TRADEMARK ATTORNEYS
4TH FLOOR, DURACK CENTRE"
263 ADELAIDE TERRACE
PERTH W.A. 6000 AUSTRALIA

Figure 1

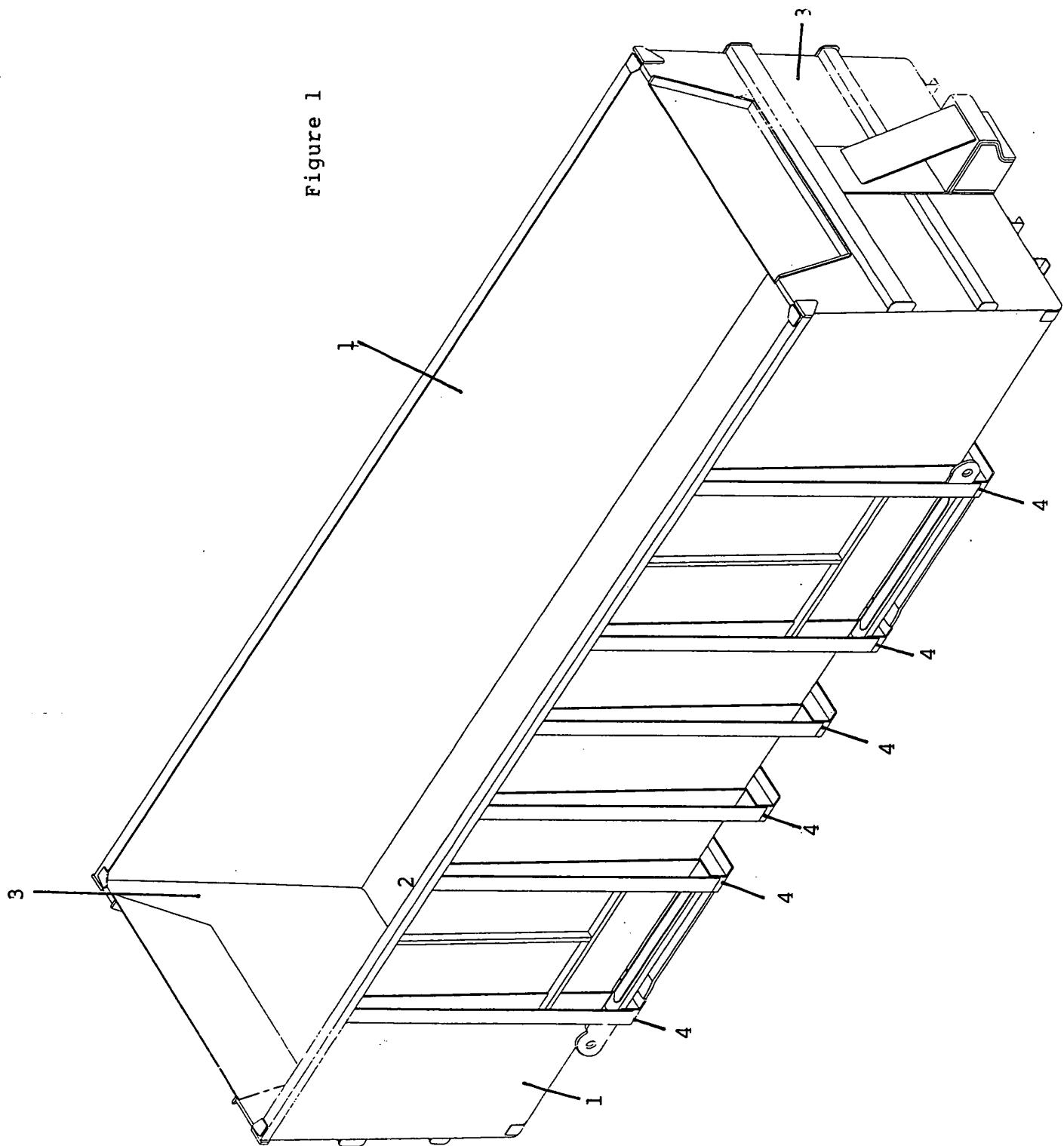


Figure 2a

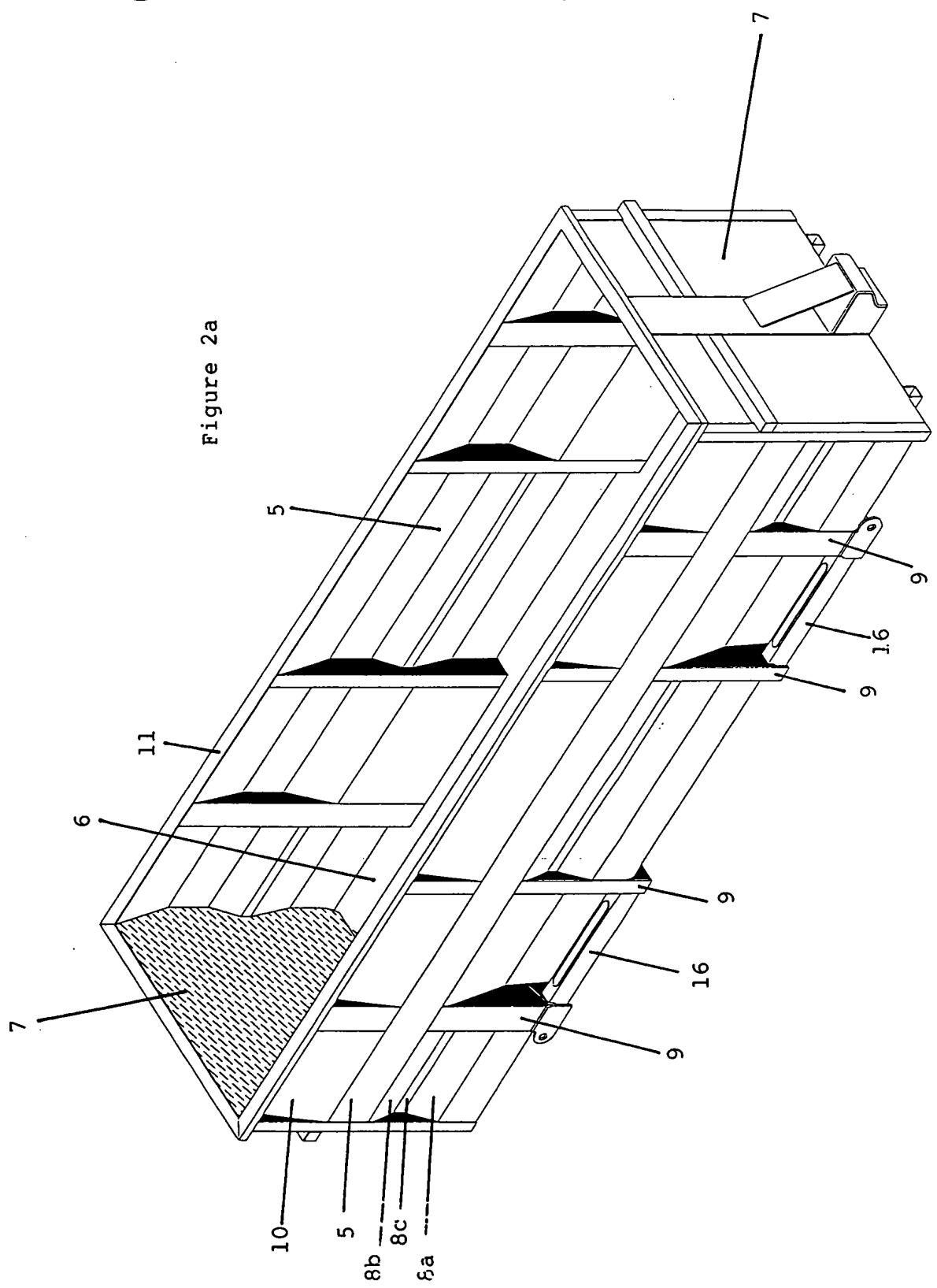


Figure 2b

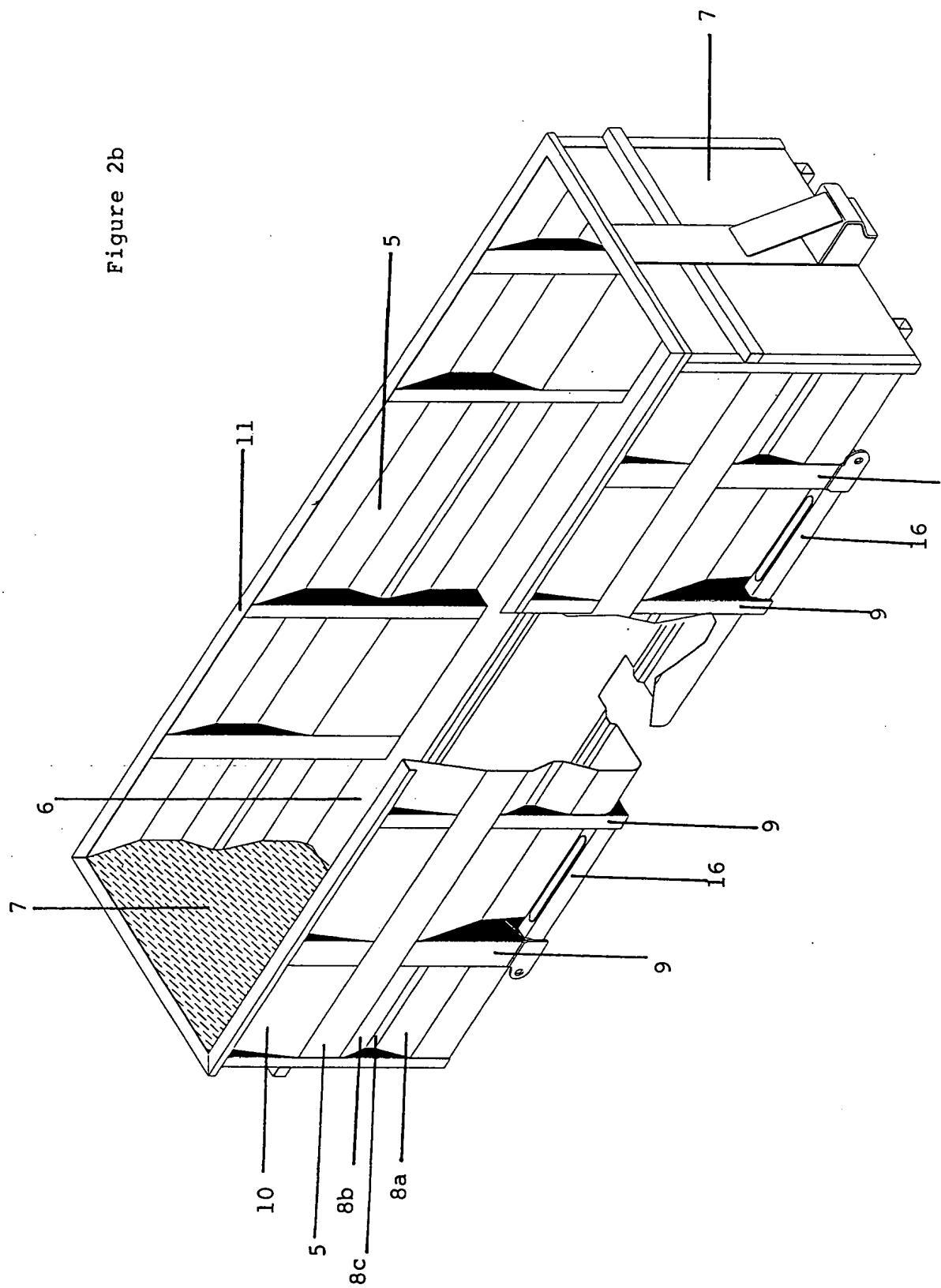


Figure 3a

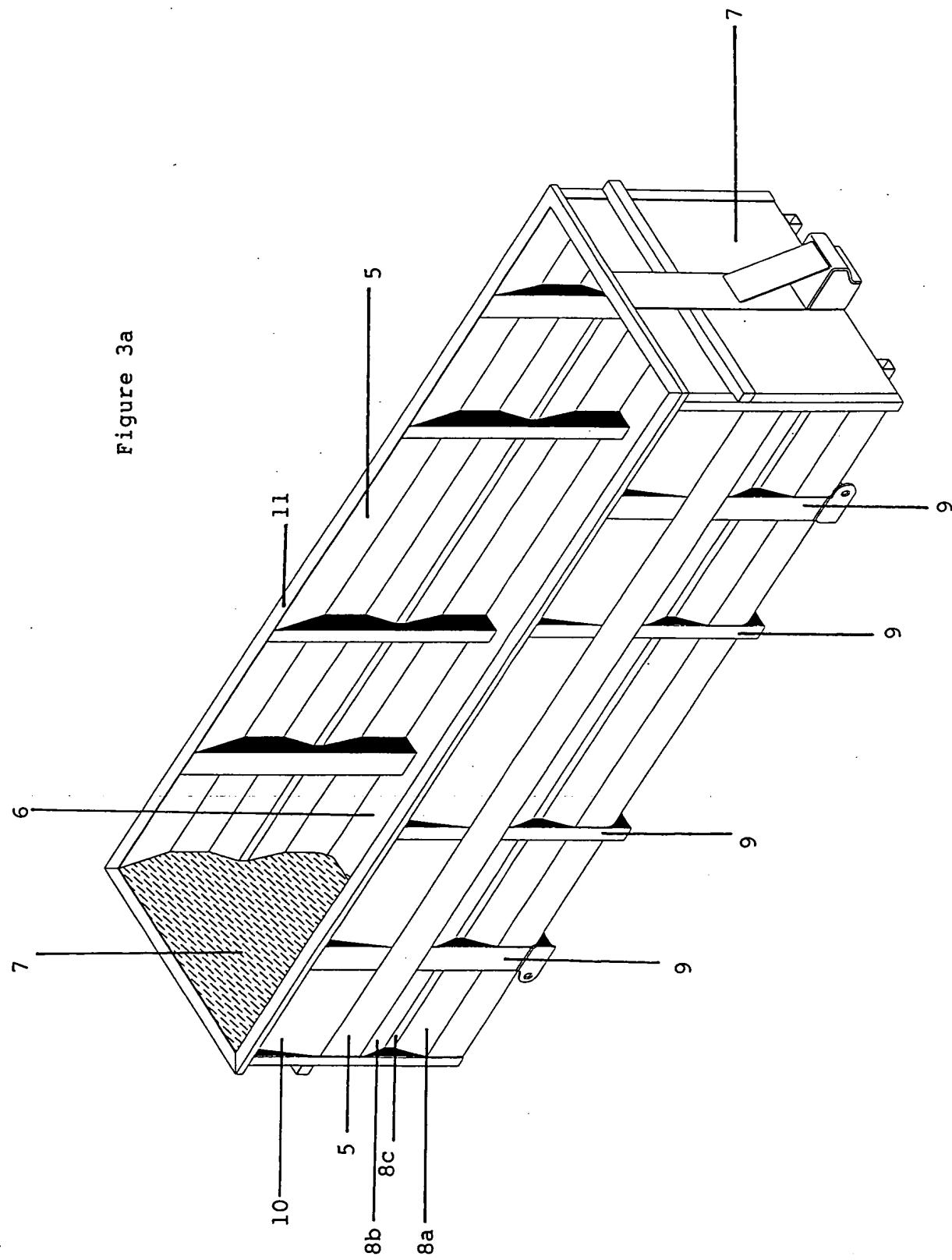
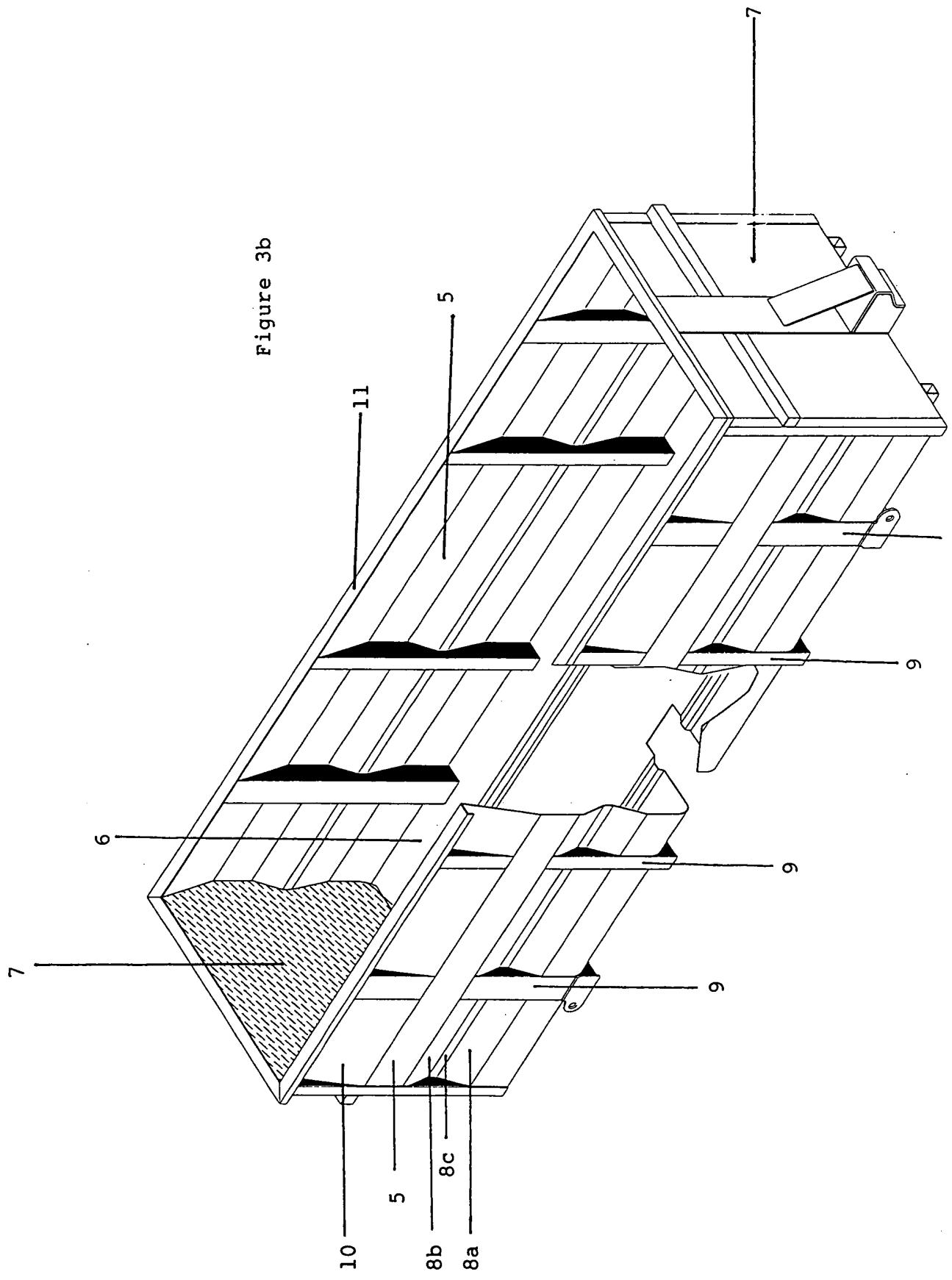


Figure 3b



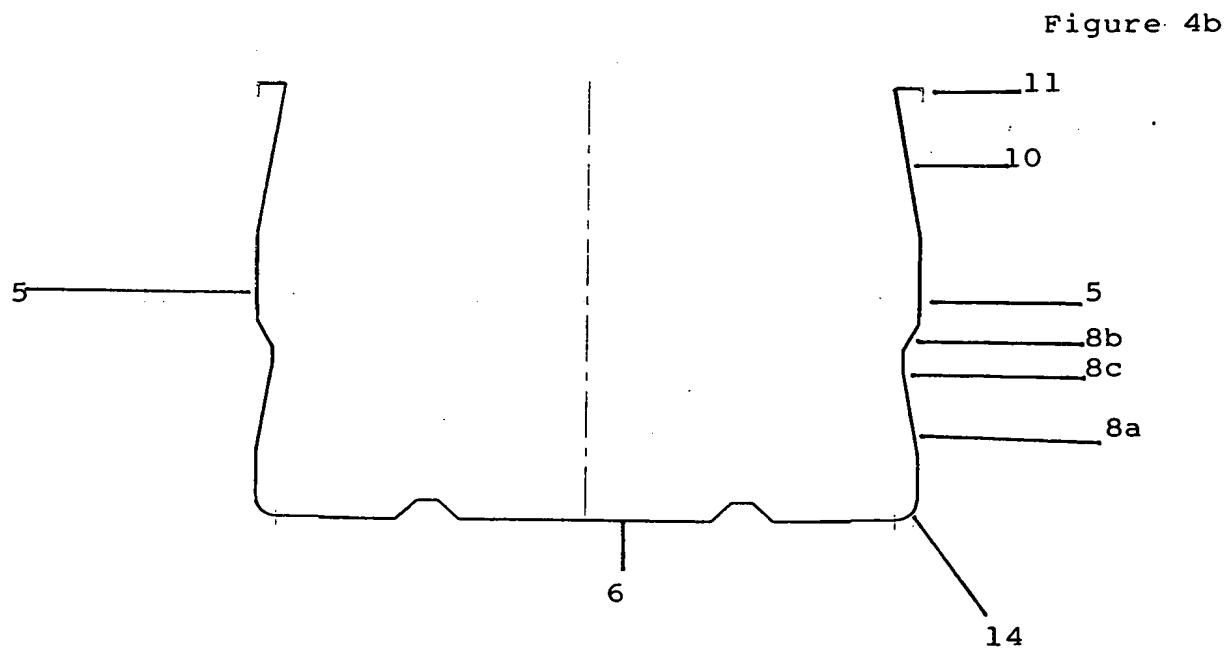
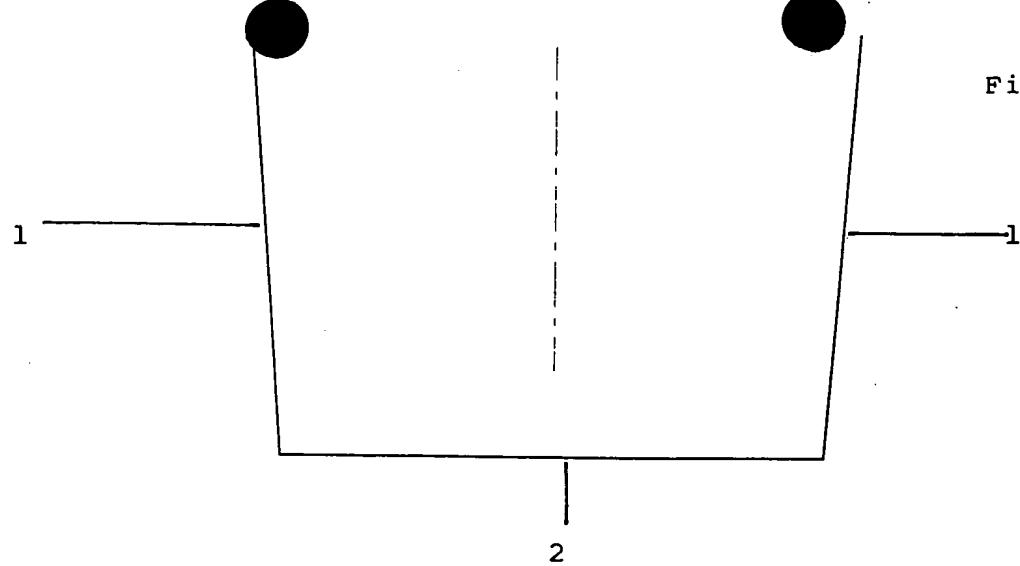


Figure 5

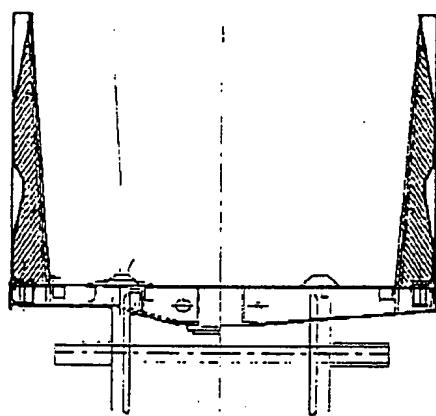


Figure 6

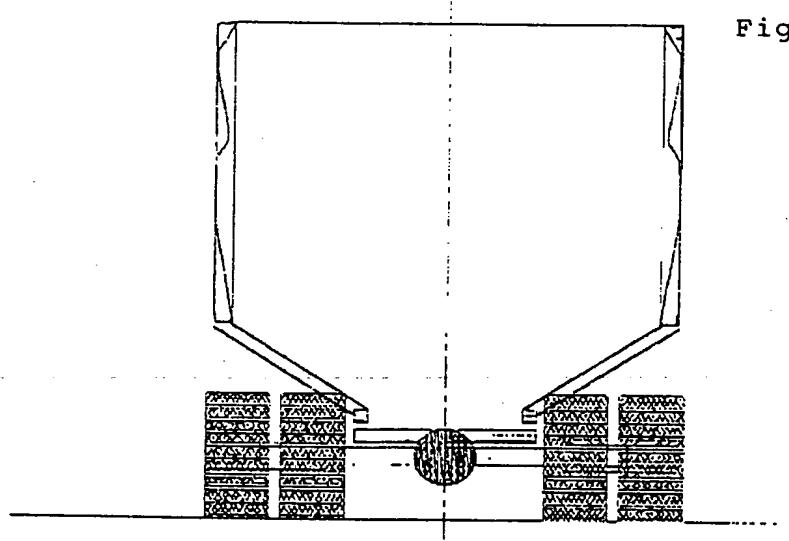


Figure 7

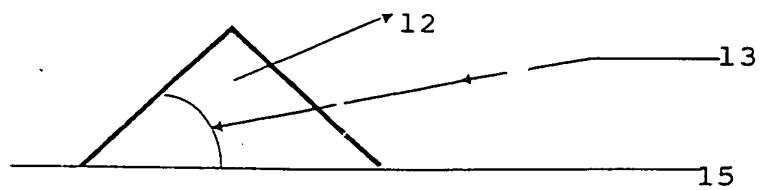


Figure 8

